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(71) Applicant:
Murata Manufacturing Co., Ltd.
Nagaokakyo-shi Kyoto-fu 617-8555 (JP)

(72) Inventors:
- **Sasaki, Yutaka**
  Nagaokakyo-shi, Kyoto-fu (JP)
- **Tanaka, Hiroaki**
  Nagaokakyo-shi, Kyoto-fu (JP)

(74) Representative:
Schoppe, Fritz, Dipl.-Ing.
Schoppe & Zimmermann
Patentanwälte
Postfach 71 08 67
81458 München (DE)

(54) Comb-line filter including distributed constant line

(57) The invention provides a comb-line filter (10) including a distributed constant line, comprising: a plurality of resonators (3, 4) each comprising said distributed constant line having an open end and a grounding end; a first grounding electrode (2) connected to each of said grounding end of said resonators (3, 4); at least two of said resonators (3, 4) put in proximity to each other and arranged side by side; an input electrode (5) and an output electrode (6) respectively capacitance-coupled to two of said open ends of said resonators (3, 4) which are located the farthest from each other; and a second grounding electrode (11) capacitance-coupled to said input electrode (5) and said output electrode (6) threrebetween.

The attenuation value in the rejection band can be improved.

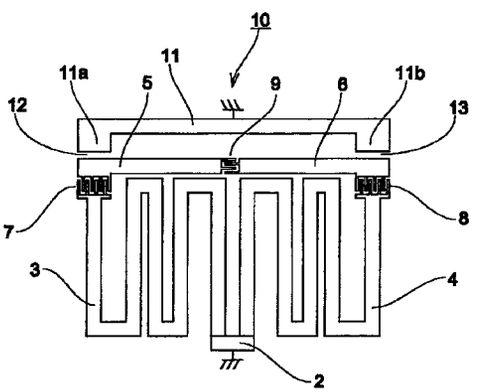

Fig. 1

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Description

BACKGROUND OF THE INVENTION

1. Field of the invention

[0001] The present invention relates to a comb-line filter including a distributed constant line. More particularly, the present invention relates to a comb-line filter including a distributed constant line for used in a RF stage of a mobile communication apparatus.

2. Description of the Related Art

[0002] Fig. 7 shows an example of a conventional comb-line filter including a distributed constant line.

[0003] The comb-line filter 1 is composed of an input electrode 5, an output electrode 6, and microstrip-line resonators 3 and 4 each comprising a distributed constant line, the length of which is approximately one fourth of the wavelength of an intended frequency, one end of which is used as an open end, and the other end of which is used as a grounding end. The grounding end is connected to a first grounding electrode 2.

[0004] Here, the two resonators 3 and 4 meanderingly bent are closely arranged side by side so that the linear portion on the side of the grounding end of each of the resonators connected to the grounding electrode 2 is coupled to each other, and the open end of each of the resonators is connected to the input electrode 5 and the output electrode 6 respectively through pairs of comb-like electrodes 7 and 8 made up of two mated comb-like electrodes facing each other. Also, the input electrode 5 and the output electrode 6 are connected through a pair of comb-like electrodes 9 made up of two similarly mated comb-like electrodes facing each other. The comb-line filter including a distributed constant line 1 is provided, for example, on the front surface of a dielectric substrate on the total back surface of which a grounding electrode is formed, and the input electrode 5 and the output electrode 6 are connected to an external circuit, for example, by wire bonding.

[0005] In the comb-line filter including a distributed constant line 1 constructed in such a way, a signal input through the input electrode 5 is input into a resonance circuit made up of the microstrip-line resonators 3 and 4 through a capacitance for attenuation pole formed by a pair of comb-like electrodes 7, and only frequencies close to an intended frequency resonate and signals of other frequencies are reflected. A resonant signal in the resonance circuit made up of the microstrip-line resonators 3 and 4 is output from the output electrode 6 through a capacitance formed by the pair of comb-like electrodes 8. In this way the comb-line filter including a distributed constant line 1 functions as a band-pass filter.

[0006] In Fig. 8, the passing characteristic of the comb-line filter including a distributed constant line 1 is shown. In Fig. 8, Characteristic x shows an insertion loss and a band-pass characteristic in which the insertion loss is decreased in the pass-band a around 2 GHz. Further, the portions having the insertion losses increased on the both sides of the pass-band a are caused by a capacitance for attenuation pole which is formed by the pair of comb-like electrodes 9 in Fig. 7.

[0007] However, in the above-mentioned comb-line filter including a distributed constant line 1, there was a problem that as shown in Fig. 8, only an attenuation value of about 18 dB is attained in the rejection bands b on the both sides of the pass-band a and accordingly a sufficient attenuation characteristic can not be obtained.

SUMMARY OF THE INVENTION

[0008] The present invention is intended to solve the above-mentioned problem, and presents a comb-line filter including a distributed constant line having an attenuation value increased in the rejection band.

[0009] A preferred embodiment of the present invention provides a comb-line filter including a distributed constant line, comprising: a plurality of resonators each comprising said distributed constant line having an open end and a grounding end; a first grounding electrode connected to each of said grounding end of said resonators; at least two of said resonators put in proximity to each other and arranged side by side; an input electrode and an output electrode respectively capacitance-coupled to two of said open ends of said resonators which are located the farthest from each other; and a second grounding electrode capacitance-coupled to said input electrode and said output electrode threrebetween.

[0010] The above described comb-line filter is able to have a larger attenuation value in the rejection band.

[0011] In the above described comb-line filter, said second grounding electrode and said input electrode and output electrode may be arranged in proximity to each other. Or, they may be arranged through a pair of comb-like electrodes comprising two mated comb-like electrodes facing each other respectively. Or, They may be arranged through a pair of MIM electrodes comprising two plane shaped electrodes sandwiching an insulating material therebetween.

[0012] According to the above structure, it is possible to make the attenuation value increased in the rejection band and to make the second grounding electrode small-sized.

[0013] Other features and advantages of the present invention will become apparent from the following description of the invention which refers to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 shows the construction of a preferred embodiment of a comb-line filter including a distributed constant line according to the present invention.

Fig. 2 shows the passing characteristic of the filter shown in Fig. 1.

Fig. 3 shows the construction of another preferred embodiment of a comb-line filter including a distributed constant line according to the present invention.

Fig. 4 shows the construction of further another preferred embodiment of a comb-line filter including a distributed constant line according to the present invention.

Fig. 5 shows the construction of further another preferred embodiment of a comb-line filter including a distributed constant line according to the present invention.

Fig. 6 shows the construction of further another preferred embodiment of a comb-line filter including a distributed constant line according to the present invention.

Fig. 7 shows the construction of a conventional comb-line filter including a distributed constant line.

Fig. 8 shows the passing characteristic of the comb-line filter shown in Fig. 7.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] In Fig. 1, one preferred embodiment of a comb-line filter including a distributed constant line according to the present invention is shown. In Fig. 1, the portions identical or equivalent to those in Fig. 7 are given the same reference numerals and their explanation is omitted.

[0016] In Fig. 1, the comb-line filter 10 has a second grounding electrode 11, and one end 11a of the second grounding electrode 11 is protruded toward the side of an input electrode 5 and arranged close to the input electrode 5 through a gap 12. Also, the other end 11b of the second grounding electrode 11 is protruded toward the side of an output electrode 6 and arranged close to the output electrode 6 through a gap 13. In this way, by giving the grounding electrode 11 in proximity to the input electrode 5 and the output electrode 6, a grounding capacitance is formed therebetween.

[0017] In Fig. 2, the passing characteristic of the comb-line filter 10 is shown. Fig. 2 shows the insertion loss, and the portions identical or equivalent to those in Fig. 8 are given the same reference numerals and their explanation is omitted.

[0018] In Fig. 2, the characteristic x shows the insertion loss of a comb-line filter 1 of a conventional example, and the characteristic y shows the insertion loss of a comb-line filter 10 according to the present invention. As understood by comparing the characteristic x and characteristic y, although both of them show almost the same characteristics in the passing band, in the rejection band the characteristic y has an attenuation value of nearly 28 dB, or nearly 10 dB larger than that of the characteristic x, that is, the characteristic y has been improved.

[0019] Thus, by giving the grounding electrode 11 in proximity to the input electrode 5 and the output electrode 6 to form a grounding capacitance therebetween, the attenuation value in the rejection band b can be improved.

[0020] Now, in Fig. 1 the second grounding electrode 11 is arranged close to the input electrode 5 and output electrode 6 only at one end 11a and the other end 11b of the second electrode 11 to provide a grounding capacitance, but as shown in a comb-line filter 20 including a distributed constant line, the entire portion of a second grounding electrode 21 of a nearly rectangular form can be provided close to the input electrode 5 and output electrode 6. In this case, the capacitance between the input electrode 5 and output electrode 6 and the second grounding electrode 21 can be made larger, and therefore the attenuation value in the rejection band b is able to be further increased. Further, in Fig. 3, the portions identical or equivalent those in Fig. 1 are given the same reference numerals and their explanation is omitted.

[0021] Further, in Fig. 1 the input electrode 5 and the output electrode 6 are connected through a capacitance for attenuation pole formed by a pair of comb-like electrodes 9 made up of two mated comb-like electrodes facing each other, but as shown in a comb-line filter 30 including a distributed constant line in Fig. 4, it is possible to eliminate the portion connecting the input electrode 5 and the output electrode 6 which forms a capacitance for attenuation pole. And in this case, the same working-effect as in Fig. 1 is shown also. More, in Fig. 4, the portions identical or equivalent to those in Fig. 1 are given the same reference numerals, and their explanation is omitted.

[0022] In Fig. 5, further another embodiment of a comb-line filter including a distributed constant line according to the present invention is shown. In Fig. 5, the portions identical or equivalent to those in Fig. 1 are given the same reference numerals and their explanation is omitted. In Fig. 5, one end 11a protruded toward the side of an input electrode 5, of the second grounding electrode 11 of the comb-line filter including a distributed constant line 40 and the input electrode 5 are connected through a pair of comb-like electrodes 41 made up of two mated comb-like electrodes facing each other. Further, the other end 11b protruded toward the side of an output electrode 6, of the second grounding electrode 11 and the output electrode 6 are connected through a pair of comb-like electrodes 42 made up of two mated comb-like electrodes facing each other.

[0023] In this way, by connecting the input electrode 5 and output electrode 6 and the second grounding electrode 11 through a pair of comb-like electrodes 41 and 42, a grounding capacitance therebetween is provided, and the same working-effect as in Fig. 1 can be obtained. Further, because this case allows a pair of comb-like electrodes of a small area to have a large grounding capacitance in the same manner as the comb-line filter including a distributed constant line 20 in Fig. 3, it is possible to make the attenuation value increased in the rejection band or to make the second grounding electrode mall-sized.

[0024] In Fig. 6, further another embodiment of a comb-line filter including a distributed constant line according to the present invention is shown. In Fig. 6, the portions identical or equivalent to those in Fig. 1 are given the same reference numerals, and their explanation is omitted. In Fig. 6, one end 11a protruded toward the side of an input electrode 5, of a second grounding electrode 11 of the comb-line filter 50 including a distributed constant line and the input electrode 5 are connected through a pair of MIM electrodes made up of two plane electrodes laid one on top of the other and sandwiching an insulating material 51a therebetween. Further, the other end 11b protruded toward the side of an output electrode 6, of the second grounding electrode 11 and to the output electrode 6 are connected through a pair of MIM electrodes 52 made up of two plane electrodes laid one on top of the other and sandwiching an insulating material 52a. Here, MIM is the abbreviation of metal insulator metal and shows the construction of two metal layers sandwiching one insulator layer to form a capacitance. Furthermore, because the comb-line filter 50 is able to have a large grounding capacitance in the same manner as the comb-line filter 40 in Fig. 5, it is possible to make the attenuation value increased in the rejection band or to make the second grounding electrode small-sized.

[0025] In this way, by connecting the input electrode 5 and output electrode 6 and the second grounding electrode 11 through a pair of MIM electrodes 51 and 52 respectively to provide a grounding capacitance therebetween, the same working-effect as in Fig. 1 can be obtained.

[0026] More, in each of the embodiments described above, the comb-line filter including a distributed constant line was composed of two microstrip-line resonators each comprising a distributed constant line, but the number of microstrip-line resonators is not limited to two and three or more microstrip-line resonators can be also used for construction. Further, in each of the embodiments described above, microstrip-line resonators were meanderingly bent, but these can take a different form such as a linear form, a spiral form, etc. Furthermore, in each of the embodiments described above, microstrip-line resonators each comprising a distributed constant line were used, but another distributed constant line such as a stripline resonator can be also used.

[0027] While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that the forgoing and other changes in form and details may be made therein without departing from the spirit of the invention.

Claims

1. A comb-line filter (10; 20; 30; 40; 50) including a distributed constant line, comprising:

   a plurality of resonators (3, 4) each comprising said distributed constant line having an open end and a grounding end;
   a first grounding electrode (2) connected to each of said grounding end of said resonators (3, 4);
   at least two of said resonators (3, 4) put in proximity to each other and arranged side by side;
   an input electrode (5) and an output electrode (6) respectively capacitance-coupled to two of said open ends of said resonators (3, 4) which are located the farthest from each other; and
   a second grounding electrode (11; 21) capacitance-coupled to said input electrode (5) and said output electrode (6) threrebetween.

2. The comb-line filter (20) according to claim 1, wherein said second grounding electrode (21) and said input electrode (5) and output electrode (6) are arranged in proximity to each other.

3. The comb-line filter (40) according to claim 1, wherein said second grounding electrode (11) and said input electrode (5) and output electrode (6) are arranged through a pair of comb-like electrodes (41, 42) comprising two mated comb-like electrodes facing each other respectively.

4. The comb-line filter (50) according to claim 1, wherein said second grounding electrode (11) and said input electrode (5) and output electrode (6) are arranged through a pair of MIM electrodes (51, 52) comprising two plane shaped electrodes sandwiching an insulating material (51a, 52a) therebetween.

5. The comb-line filter (10; 20; 30; 40; 50) according to claim 1, wherein said distributed constant line is a microstrip-line.

6. The comb-line filter (10; 20; 30; 40; 50) according to claim 1, wherein said distributed constant line is a stripline.

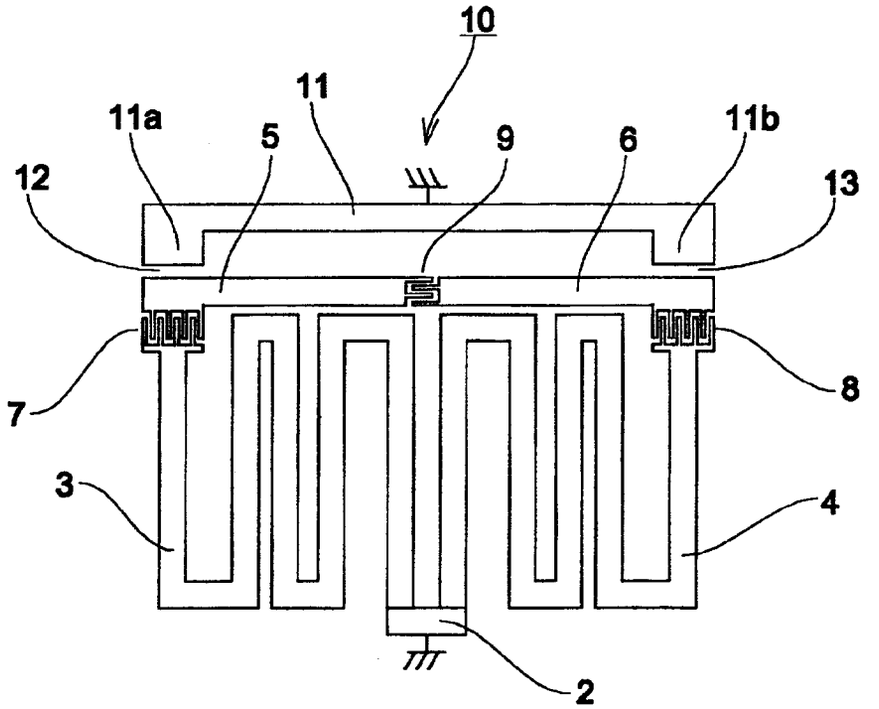
10
11
11a
5
9
6
11b
12
13
7
8
3
4
2

Fig. 1

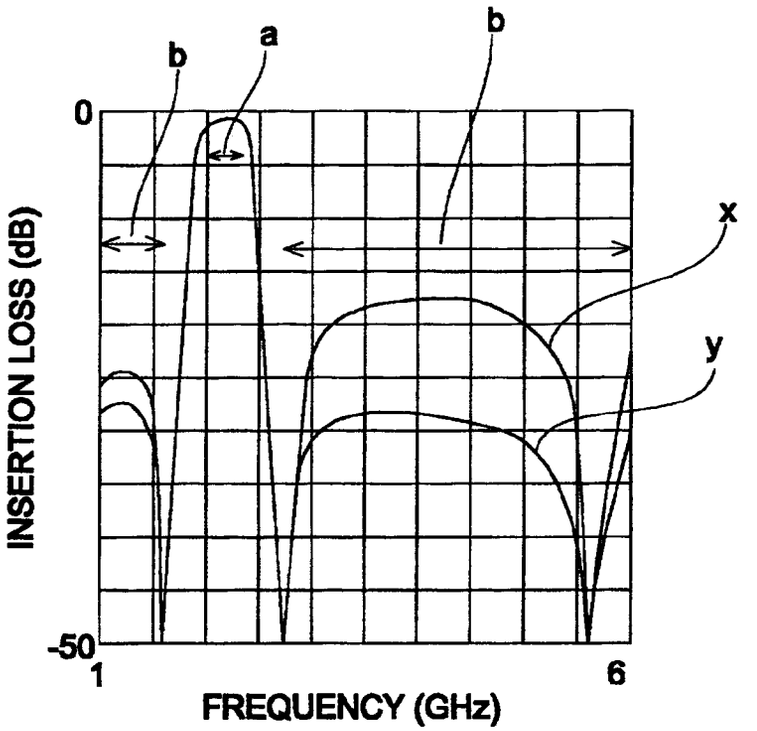
b
a
b
0
x
y
INSERTION LOSS (dB)
-50
1
6
FREQUENCY (GHz)

Fig. 2

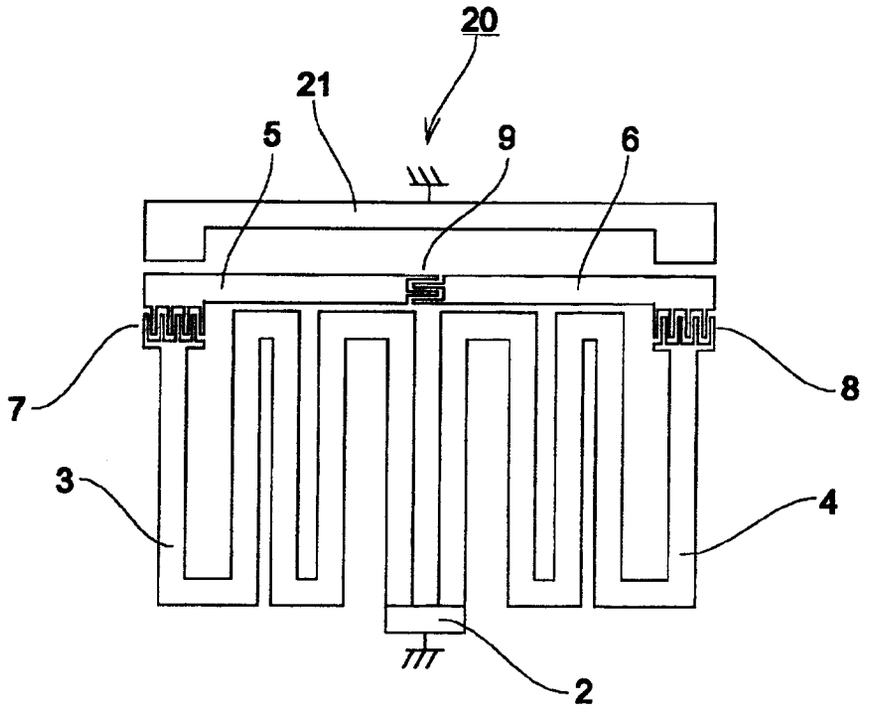

Fig. 3

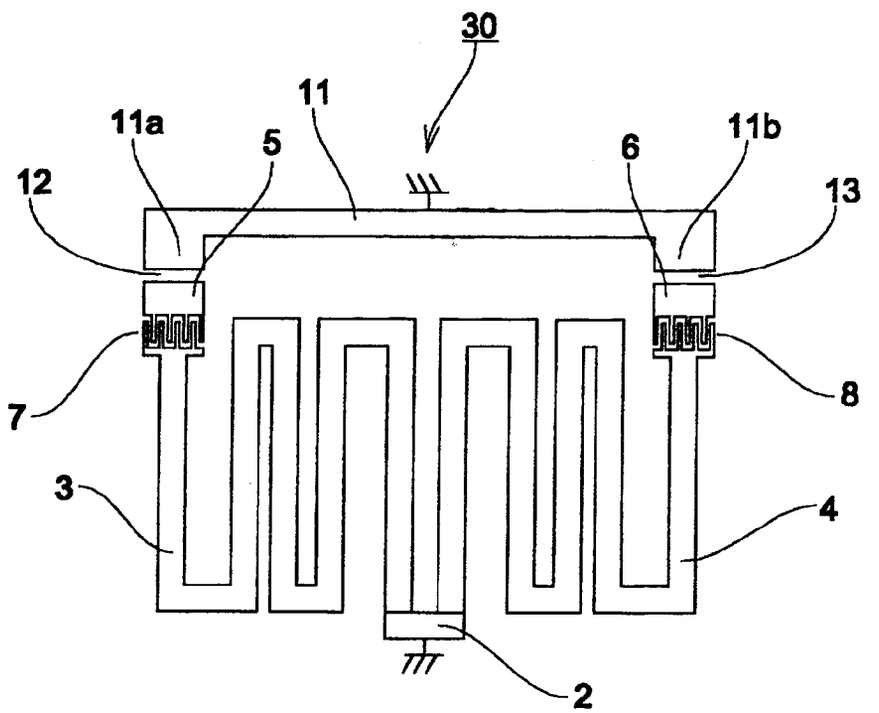

Fig. 4

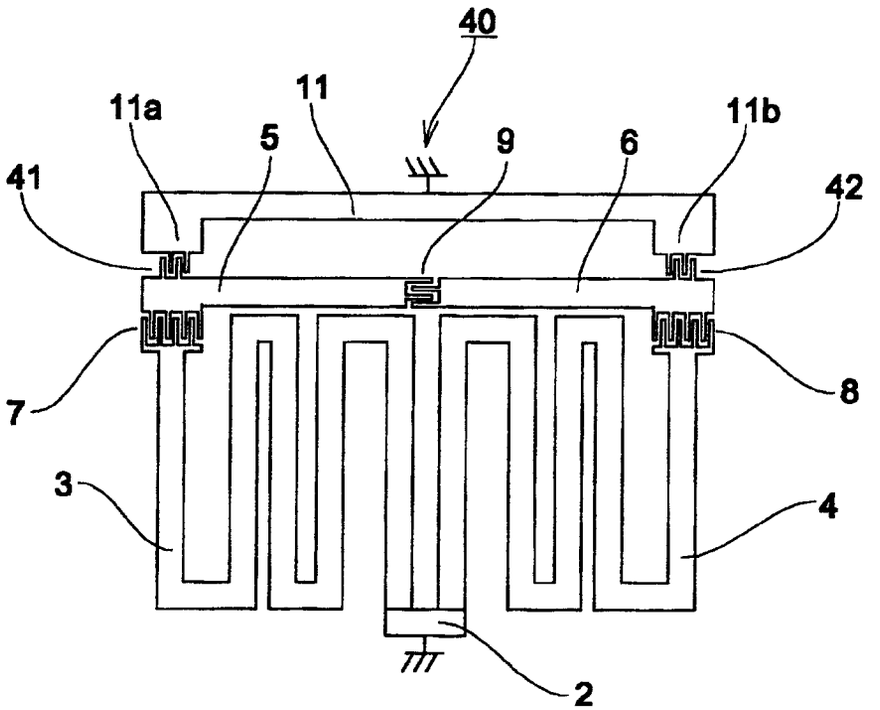
40
11a
11
5
9
6
11b
41
42
7
8
3
4
2

Fig. 5

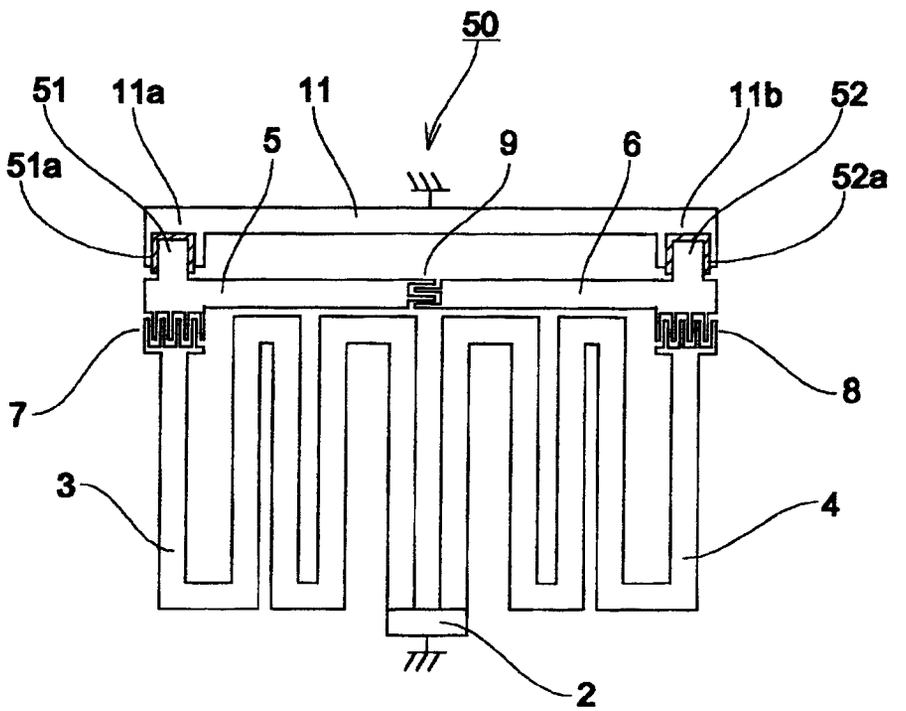
50
51
11a
11
11b
52
5
9
6
51a
52a
7
8
3
4
2

Fig. 6

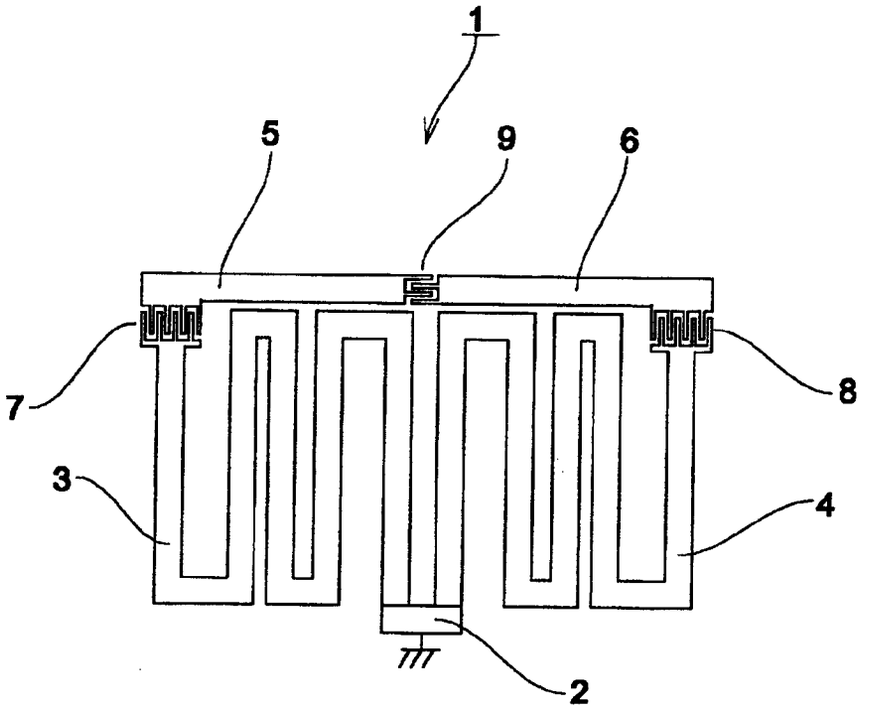

Fig. 7 PRIOR ART

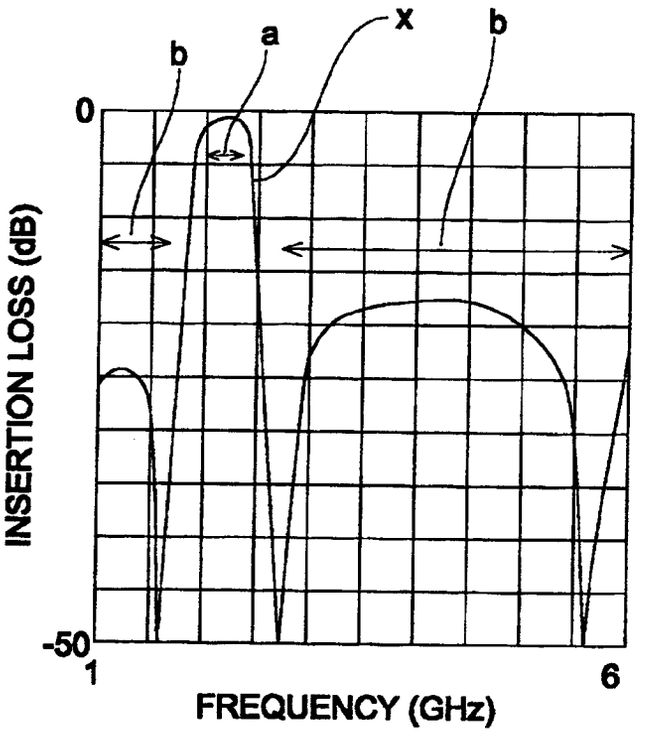

Fig. 8 PRIOR ART

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 12 2249

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
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X	EP 0 641 035 A (MATSUSHITA ELECTRIC IND. CO., LTD.) 1 March 1995 * page 16, line 18 - line 29 * * page 16, line 54 - page 17, line 52; figures 8,10,12,13 * ---	1-3,6	
A	US 3 451 015 A (HEATH) 17 June 1969 * column 7, line 51 - column 8, line 33; figures 9,10 * ---	1	
A	WEN-TENG LO ET AL: "K-BAND QUASI-PLANAR TAPPED COMBLINE FILTER AND DIPLEXER" IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, vol. 41, no. 2, 1 February 1993, pages 215-223, XP000361234 * page 215, right-hand column, line 29 - line 43; figures 1,2 * -----	4	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

H01P

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 February 1999	Den Otter, A

CATEGORY OF CITED DOCUMENTS

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25-02-1999

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